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## The Implementation of the 5E Learning Cycle in Stem Freedom School Curriculum

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THE IMPLEMENTATION OF THE 5E LEARNING CYCLE  
IN STEM FREEDOM SCHOOL CURRICULUM

by

Natasha Semanko

A capstone project submitted in partial fulfillment of the requirements for the degree of  
Master of Arts in Teaching.

Hamline University

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## ABSTRACT

The project titled “Implementation of the 5E Learning Cycle in STEM Freedom School Curriculum” was completed by Natasha Semanko in the summer of 2020. For this project, two weeks of new curriculum was created for STEM Freedom School. Each lesson followed the 5E inquiry cycle and focused on topics within the theme of Environmental Studies and Sustainability. Lesson topics included the water cycle, groundwater contamination, pollution in lakes/rivers/oceans, overfishing, and the food chain. In this curriculum, students create a presentation or poster of the material to share with families and visitors at the End of Year Showcase. The key influences of this project were Allen, Harron, Qadri, and Rodriguez (2019) and Dass (2015) with their definitions and explanations of each stage in the 5E inquiry cycle, and Nargund-Joshi and Bautista (2016) with the suggestion of combining the 5E inquiry cycle and the Sheltered Instruction Observation Protocol (SIOP) to provide further support for English Language Learners. The curriculum created for this project will be implemented in the Summer of 2021. Through observation and analysis of student learning, the effectiveness of the implementation of the 5E learning cycle will be determined.

## TABLE OF CONTENTS

ABSTRACT.....	2
CHAPTER ONE: Introduction.....	5
First Summer at Freedom School.....	6
Second Summer at Freedom School.....	6
Project Proposal.....	7
Third Summer at Freedom School.....	8
Summary.....	9
CHAPTER TWO: Literature Review.....	11
The 5E Learning Cycle and Implementation.....	12
Engagement.....	21
Equity.....	26
Summary.....	31
CHAPTER THREE: Method.....	33
Context/Setting.....	34
Rationale.....	35
Framework.....	36
Project Completion.....	36
Summary.....	37
CHAPTER FOUR: Conclusion.....	39
Major Learnings.....	39
Literature Review.....	42

Limitations.....	44
Implications.....	45
Future Research and Next Steps.....	45
Summary.....	46
REFERENCES.....	48

## CHAPTER ONE

### Introduction

Looking back at the past five years of my life, my education, experiences, and passion have led me to this moment. I have worked tirelessly to give back to my community and help as many students as possible, and now I have the opportunity to create a curriculum that will impact hundreds of students for years to come. For the past three summers, I have been involved in Freedom School, and now it is my pleasure to give back to this program after everything it has done for me. For the completion of the Master of Arts program at Hamline University, I will work with a local museum to implement the 5E learning cycle in a Freedom School site to promote inquiry and student centered learning. This project will answer the research question: How will integrating the 5E Learning Cycle into STEM Freedom School increase student centered learning? This chapter will describe my journey to this current project, why it is important to complete, and who will be positively impacted by this project.

My journey to this project started three years ago when I first applied to be an intern for a local museum. I knew that I wanted to be a teacher, and I wanted to get as much experience with youth as I could. I applied to be a STEM educator for a program I had never heard of before. I received an interview, and I came to realize that around twenty other people would be part of the interview. I was placed with a group of individuals I had never met before, and I was asked to craft a lesson about anything. We were given all of the resources the museum had to offer, and we were given twenty minutes to create a lesson with strong content that was also enjoyable. Immediately, we decided on an idea we could implement in the amount of time we were given, and I took

charge with the planning process. While we gave our lesson to the individuals that would be my future bosses, I completed most of the instruction because my partners were not as confident or willing to teach a room full of strangers. After a few weeks, I found out that I received the internship, and that I would spend the summer teaching science. I had never been a huge fan of science before, but I was willing to do anything I could to give back to the youth in my community.

### ***First Summer at Freedom School***

For the summer of 2017, I taught K-2 students about human biology and public health, engineering and design, environmental studies and sustainability, and media and technology. I struggled with the lesson plans I was given because some of my students were quite young, so it was very hard for them to comprehend what was going on. For most lessons, I was running around the room trying to help as many students as I could, while the older kids were finished with the project and ready to go home. I could not help but think that the students deserved better, and that there needed to be lessons that were appropriate for the level the students were at. I felt very emotionally connected and committed to the group of students that I was working with that summer. I was able to learn about different cultures, get to know different student perspectives of learning, and I was able to give love to 26 students every day.

**Second Summer at Freedom School.** Because of my connection to the students I had been working with, I applied to come back to the same program the next summer. For this summer, I took a different position that allowed me to work with the students all day. I had my own classroom that I was able to decorate, I had a class list of students I was responsible for, and I was held to the same standard as teachers. During the first half

of the day, I taught the literacy curriculum that was provided by the program. We were able to read a different book every day that related to the student population at our site, and it allowed us to discuss challenges that my students were facing. During the afternoon portion of the day, a STEM educator would come into my room and teach the STEM content. For the summer of 2018, I taught literacy for grades 3-5, which was a different curriculum than the summer before. I witnessed the STEM educator I was partnered with struggle through every lesson because the students were not interested in the content, the activities were too easy, and they did not know how the content was related to them. I did my best to support my fellow teacher, but my students struggled to stay interested in the STEM activities they were provided.

***Project Proposal.*** When it was time to start thinking about what I wanted to do after student teaching and graduation, I was overwhelmed with all of the possibilities I could pursue. I decided that I wanted to continue with the MAT program, but I had no idea what I wanted to do for a project or thesis. Over a few weeks, I thought about what areas of education interest me, and what I could do to improve an educational experience for others. I was reminded of my students from the past two summers, and I knew that I could do something to improve this summer program. I knew that the STEM curriculum needed many changes, and as I crafted my project proposal, the 5E learning cycle came to mind. I like this learning cycle because it gives students more freedom in the learning process, and it effectively helps students develop problem solving and critical thinking skills. I also wanted to address that the current activities were not appropriate for the assigned age groups, and that students needed to be interested and connected to what they were learning about.



After creating a project proposal, I met with my manager from two summers ago. I explained that I was continuing my education, and that I wanted to complete a project to help the students at the site we worked with. I explained how the 5E learning cycle worked, and my perspective of the current curriculum. My manager was very receptive and excited to work with me to improve the curriculum for our students. He suggested that I serve as a support staff for the summer, which meant that I would not have my own group of students for the first time. I was sad that I would not have my own class, but I was excited to provide support for students in each grade level. During the summer of 2019, I served as the site lead with one other individual, and I helped the new teachers with classroom management and instruction techniques. I was able to reconnect with my students from two years before and continue to serve as a role model in their lives.

***Third Summer at Freedom School.*** Over the summer of 2019, we had extreme behavior issues across our site. Students were not engaged in the lessons, they did not want to learn about literacy or STEM, and they were tired of doing the same activities every year. Feedback from other teachers and my observations of lessons gave me the information that I needed for creating a curriculum that would be better for our students. I continued to learn about the 5E learning cycle, look for new STEM activities, and try out different activities for future summers. I created a plan for my curriculum project, which would answer the question: How will integrating the 5E Learning Cycle into STEM Freedom School increase student centered learning?

This project will impact all of the students at this Freedom School site, the managers of the program, and the future teachers that will implement this curriculum. This project needs to be completed so that students can become more engaged in the

content, improve their critical thinking skills, and be exposed to an equitable learning environment. Their current educational experience is not engaging, culturally responsive, or a learning process that is guided by the student. To address the needs of the students that attend this program, the 5E learning cycle will be implemented into each lesson, and new relevant activities will be created. According to Putra, Kholifah, Subali, and Rusilowati (2018), the 5E learning cycle allows the inquiry process to become more meaningful and engaging through students' critical thinking and hands-on involvement in the process. This cycle also allows students to use prior knowledge, engage in debate of previous conceptions, and partake in a higher level of thinking while viewing how the content is relevant to themselves (p. 173). STEM Freedom School is the main way that students in this community are involved in STEM because of the small amount of time it is allotted in school. Without this project, students will continue to do the same activities every year, which will lead to disengagement and prevent students from pursuing STEM careers. With the completion of this project, students will receive content that is student centered, engaging, and equitable in their learning experience.

### **Summary**

For the past three summers, I have worked in different roles for the same Freedom School site. I have been able to engage with different students through my different roles, and I have been able to keep strong relationships with my previous students. My experience with this program has given me insight on the changes that need to occur for the STEM curriculum for this program to be relevant, engaging, and equitable. I will be creating a new curriculum that utilizes the 5E learning cycle, which allows students to be a guide in the learning process and pursue their area of interest. This curriculum will

impact hundreds of students, and I hope that it will continue to evolve and be modified for the students at this school. The next chapter will explain the research that is relevant to this project, and how this information will help answer the research question. In the following chapters, a project description will be given, as well as a conclusion and reflection after the completion of this project.

## **CHAPTER TWO**

### **Literature Review**

Within the field of Education, there has been significant research conducted on STEM education and engagement. Researchers have looked at specific aspects of STEM education such as: different inquiry learning cycles, student centered learning, engagement, and equity. These aspects are connected to other areas of education but are extremely prevalent in the discussion of improving STEM education for all students. The significant research in these various areas gives educators the knowledge needed to implement positive changes into curriculum for schools and other educational programs. This review aims to identify the research and information that is necessary to guide the improvement of a STEM education program. It is vital that these programs are further developed and improved to promote equity within the field, as well as student centered learning.

The three areas that will be discussed in this review are the 5E learning cycle, engagement, and equity. The 5E learning cycle involves the 5 stages of: engagement, exploration, explanation, elaboration, and evaluation. This cycle focuses on student centered learning and inquiry, and it is commonly modified to meet the needs of a specific classroom (Dass, 2015, p. 6). For students to be able to successfully learn content, they need to be engaged in what they are doing. Student engagement occurs when students are interested in what they are learning or doing. It is the goal of every teacher to keep their students engaged in the learning process, which means finding ways to make it relevant and interesting to your students (Payne, 2019, pp. 647-652). Another very important piece of education is equity. In recent years, educators have changed their

focus from equality to equity. This means that all students are not going to be treated the same or be given the same educational experience because each student is different. Teachers are focusing on giving each student what they need to fully help them thrive as a learner (Januszyk, Miller, & Lee, 2016, pp. 47-48). Knowledge and research on the three aspects of the 5E learning cycle, equity, and equality is critical to answer the question: How will integrating the 5E Learning Cycle into STEM Freedom School increase student centered learning?

### **The 5E Learning Cycle and Implementation**

The 5E learning cycle focuses on inquiry-based learning to promote student engagement, critical thinking, and collaboration. This cycle has evolved from other inquiry cycles, and educators continue to modify and adjust this cycle to best serve their population of students. Inquiry based learning can be connected to Vygotsky's social constructivism theory, which values interaction and social collaboration. The 5E learning cycle is most commonly used in STEM education, but it has also been used in many other subjects. This cycle is a valuable classroom tool for increasing engagement, inquiry, and maker-centered learning in the classroom (Allen, Harron, Qadri, & Rodriguez, 2019, pp. 49-50).

By establishing the importance of the STEM content and its' real life applications at the beginning of the learning cycle, students are more likely to gain interest and pursue involvement in the cycle. Students engage in problem solving, the learning of new content, and they are given the chance to interact with the content the way scientists and engineers do. Science requires students to apply their knowledge to real world problems, so it is critical that the relevance of the information is made clear. This allows students to

connect the content to areas they are passionate about, and it acknowledges that people can try to change the world for the better at any age. The 5E learning cycle is a unique pedagogical tool that can be implemented by educators to further engage and motivate students to interact in STEM and other areas (Dass, 2015, p. 5).

The 5E learning cycle starts with the first stage of Engagement. This stage is where the teacher introduces the topic and determines the knowledge that students have of the subject. The teacher asks open-ended questions, helps students create questions, and generates curiosity of the subject. During this phase, students question the subject, brainstorm, or complete small activities to gain interest and motivation around the subject area. This stage allows the teacher and students to make connections with the material, and to determine how it is relevant to their lives (Allen et al., 2019, pp. 50-51). If this stage is not completed properly, students will not want to proceed to the other four steps of the learning cycle. To hook students into the connect, the instructor can do a small demonstration, play a video, or give students a real life or hypothetical situation. It is also important to not overwhelm students with new and complicated vocabulary or to give students definitions or answers. If students are already given the content for the lesson or scared away because of the complexity of the content, the cycle will be negatively affected (Dass, 2015, pp. 6-7).

The second stage is Exploration, which is where students ask their own questions and explore ways to find the answer. This stage gives students the opportunity to try different methods and to make mistakes in their inquiry process. Students can create a plan, a design, or engage in a collaborative process to identify how they will answer their wonderings. It is important that the teacher creates an environment that is open to failure

and celebrates trial and error. During this stage, the teacher can guide collaboration, monitor equipment use, or challenge students to dive deeper in this stage (Allen et al., 2019, pp. 50-51). Students can conduct experiments, build prototypes, do online research, and many other ways to gain information about their problem. This stage has students start the process of finding answers to their lingering questions, and it should be as hands on as possible. The students should be exploring information and possibilities during this stage, not trying to define vocabulary or explain a phenomenon before gaining the necessary information (Dass, 2015, pp. 7-8).

Explanation is the third stage, where students explain their understanding of the subject and the involved concepts. Students put the concepts into their own words, which will help improve and deepen their understanding. This stage could involve students pitching ideas to each other or discussing their knowledge with the class. The teacher supports this process by guiding discussions and encouraging student sharing. Important ideas or information should be highlighted by the teacher, as well as the necessary information to deepen understanding (Allen et al., 2019, pp. 51-52). Students are explaining their perspective of the content by synthesizing the data they collected during their exploration and relating it to the problem at hand. This is the stage where new information or vocabulary can be introduced, and the teacher might engage in a small lecture to provide the information that is needed to proceed to the next stage. It is important that the small lecture is relevant to the research the students conducted, and it flows well with the inquiry process that is occurring. First, students should present their ideas and view of the content, then, the teacher should correct misconceptions or provide additional information (Dass, 2015, pp. 8-9).

The fourth stage is elaboration, where students use their new understanding of the information to improve their designs/plans. Students will revise their definition of the concept and further connect to the topic. New experiments can occur during this stage, and students should be collaborating with others about their ideas and view of the subject. The teacher will support students in the application of their new vocabulary or knowledge and continue to encourage students to connect this lesson to their lives or community (Allen et al., 2019, pp. 52-53). Students might ask new questions, attempt to solve new problems, or research connected problems that have peaked their interest. Another project or experiment could occur in this stage, or students could create a plan to implement their problem solving plan to benefit their community (Dass, 2015, p. 9).

The final stage of the 5E learning cycle is evaluation. Students will finish their plan or design and self-reflect on the process and their end result. This allows students to evaluate their progress and understanding of the lesson, and it could spark students interest in connected topics or experiments. In this stage, the teacher will question the students or observe the creations of the students. The teacher will assess the understanding of students, which can be used to adjust further lessons. Lastly, final misconceptions can also be addressed in this stage to ensure that students have an accurate understanding of the subject matter (Allen et al., 2019, pp. 52-53). It is important to note that teachers should try to have students move through the five stages as smoothly as possible to help with the flow of the lesson. Depending on the content of the lesson, the 5E learning cycle could last for one class period or multiple days (Dass, 2015, p.10). This cycle is a partnership between guided learning and allowing students to have some control over their learning journey.



Implementing the 5E learning cycle in science classrooms is critical because it focuses on guided discovery learning, which allows students to be the investigators, researchers, and scientists, while the teacher guides them through the process. Through guided discovery learning, students partake in hands on learning and have control over what direction the experiments or project heads. This kind of instruction requires a balance between the guidance of the teacher and the scientific creativity of the students. Without the guidance of a teacher, research has shown that discovery learning is not effective. Janssen, Westbroek, and Driel (2014) list two ways for teachers to be supportive during guided discovery learning. First, teachers can help students pose questions or structure a plan for the research project. Second, teachers can identify the ways this is a problem, and help students brainstorm solutions for the problem. Without the support of teachers during this learning process, students might not learn the intended information or reach the curriculum requirements of the lesson (Janssen, Westbroek, & Driel, 2014, pp. 69-70).

For guided discovery learning to be successful, there needs to be a community-centered environment within the classroom. According to Turner (2011), each classroom needs established norms that make each student feel valued and safe to be themselves and to ask questions in the classroom. The norms of valued learning, high academic achievement, and positive behavior should also be present in a community-centered classroom. Establishing these norms allows for students to engage in the collaborative process of the 5E learning cycle, where mistakes and trying out of the box strategies are praised. Classrooms with caring communities within them have reported better conflict management skills, higher self-efficacy, and increased motivation. A community-

centered classroom is ideal for implementing collaborative learning cycles because it supports all students during their collaborative and experimental learning process (Turner, 2011, pp. 126-127).

In a study conducted by Brown and Votaw (2008), the effectiveness of the cycle was tested when working with the topic of solubility. The study was composed of sixth-grade students that had received a small amount of previous instruction on density. For this specific lesson, the objective was for students to be able to explain how a lava lamp operates using the vocabulary of hot/cold, density, and solubility. The engage portion of the lesson involved a small experiment with raisins and soda. Second, students explored by creating their own lava lamp. Third, students explained how their lamp worked and dove deeper into the content of the lesson. Fourth, students elaborated by conducting their own research online. Lastly, the students were evaluated through various formative assessments, the work they completed in their lab notebook, and a summative assessment (Brown & Votaw, 2008, pp. 28-33).

Through the data collected from the summative assessment, it was discovered that 95 percent of students could explain how a lava lamp operated. Around 97 percent of students used the terminology of heating/cooling, 95 percent explained molecular movement with heating and cooling, and 48 percent of students discussed density. Despite the majority of students being able to properly explain the content of the lesson, there were still 21 percent of students that believed the misconception that the molecules stopped moving. This indicates that there needed to be further instruction or guidance in the area of misconceptions. When asked what they liked about the lesson, students mentioned the hands on activity of making a lamp, having control over the colors, and

watching their creation operate. With the support of the 5E learning cycle, this lesson was successful in educating 95 percent of the students within the class (Brown & Votaw, 2008, pp. 28-33). The success of this lesson cannot be generalized to the success of the 5E learning cycle as a whole, but it is a representation of the success that can come from implementing this cycle in a way that meets the needs of your students.

There has been significant research conducted on the 5E learning cycle, and with this research, modifications of the cycle are commonly proposed. In an article by Lottero-Perdue, Bolotin, Benyameen, Brock, and Metzger (2015), it was proposed to replace the second stage of exploration with the engineering design process (EDP) instead. During this proposed stage, students would start working in teams to start brainstorming solutions for the identified problem. Students need to consider criteria, their prior knowledge, and possible constraints during their problem solving process. After working through possible solutions or experiments, the group picks one solution to further plan, research, and test. The teacher can assist in this stage by providing constraints or criteria for the project or helping prompt students to create unique and creative solutions. After students complete the EDP stage, they could proceed onto the third stage of explanation. Adjusting the cycle to include this stage could benefit projects that are more engineer driven, or projects that are more in-depth or specific (Lottero-Perdue et al., 2015, pp. 61-62).

When implementing different methods or cycles into the classroom, it is critical to think about the students within your classroom. It is very challenging to meet the needs of every student within the classroom, but there are accommodations and modifications that can make lessons more enjoyable and effective for students with differing needs. The

article “Which Comes First- Language or Content?” discusses how the 5E learning cycle can be implemented and modified to meet the needs of English language learners (ELL’s) within the classroom. This article explains the importance of teaching content-based language, which has been proven to improve comprehension and proficiency of ELL’s. When implementing the 5E learning cycle, it is important to plan the moments you will provide important vocabulary to your ELL students, what supports you can provide, and what opportunities you will give them to practice and implement the new language (Nargund-Joshi & Bautista, 2016, p. 25).

Nargund-Joshi and Bautista (2016) also proposed the combination of the Sheltered Instruction Observation Protocol (SIOP) language assistive framework with the 5E learning cycle to improve and adapt instruction for ELL’s. This framework has the eight different components of: preparation, building background, comprehensible input, strategies, interaction, practice/application, lesson delivery, and review/assessment. Both frameworks stress the importance of active learning, but the desired end result is different. The 5E learning cycle prefers that students create their own definitions and meaning, but the SIOP framework prefers that the concepts and vocabulary are introduced and provided by the teacher. To combine both frameworks, teachers can place a higher focus on accessing prior knowledge and building background for the current lesson. Teachers can also include more opportunities for vocabulary discussion and implementation of new vocabulary. The combination of the 5E learning cycle and the SIOP framework addresses the needs of ELL’s while still focusing on the guided learning process. It is also important to note that the combination of the 5E learning cycle and SIOP framework can be adjusted based on the content being taught. There are scientific

topics that would benefit from the teacher introducing the concepts and vocabulary, as seen in the SIOP framework. Integrating this piece of the SIOP model would be critical for completely new content that students might lack prior knowledge in. For other topics that students have experience with, implementing a more traditional 5E cycle could be beneficial because it allows students to create their own definitions (Nargund-Joshi & Bautista, 2016, pp. 27-30). When lessons are prepared for and executed properly, the combination of SIOP framework and the 5E cycle gives students of different backgrounds the opportunity to be young scientists.

A similar article by E. Duran, L. Duran, Haney, and Scheuermann (2011) suggests adding another stage to the cycle to give students a short pause in the cycle. With the implementation of the express stage, the teacher would be able to ensure that all learners are continually progressing and on the right track. The express stage would be the fourth out of the six stages, that would serve as a time specifically for formative assessment. This assessment would give the teacher the opportunity to provide additional instruction, to adjust the lesson, or to debunk a misconception that is affecting the lesson. Additional instruction or changes would take place in the following stage of elaborate, where students would continue to broaden their understanding of the content. This proposed change would give teachers more opportunities to give support to high achieving students, ELL's, and struggling learners. This article also addresses that this cycle can be modified and adjusted in various ways, so that it is in the ideal format for your specific group of students (E. Duran et al., 2011, pp. 57-60). Researchers are still proposing new modifications or additions to the 5E learning cycle, which provides many opportunities for educators to implement the version that works best for them.

The traditional 5E learning cycle includes the stages of engage, explore, explain, elaborate, and evaluation. This cycle aims to increase student engagement and student centered learning in STEM education and other subjects. The 5E learning cycle can also be modified to meet the needs of a specific group of students. Nargund-Joshi and Bautista (2016) suggested combining the 5E learning cycle and SIOP framework to provide extra support for ELL's. Another modification of the cycle was proposed by E. Duran et al. (2011), which suggested adding an extra stage in the cycle for formative assessment. When properly implemented, this cycle can allow students to be the experimenters and guides through the learning process, which gives them more control over how they learn. This increases student interest and engagement, which is critical for successful learning.

### ***Engagement***

With the implementation of the 5E learning cycle, it is the hope that the learning experience becomes more meaningful and authentic. This cycle promotes critical thinking, creativity, and problem solving, which should increase student engagement and interest. For students to improve these various skills, they will need to be interested and engaged in the content, or they will not fully learn the information. In a study conducted by Putra, Kholifah, Subali, and Rusilowati (2018), the level of engagement during the 5E learning cycle was tested. This study collected classroom action research to analyze the motivation, engagement, and understanding of students while completing the cycle. Putra et al. (2018) found that the 5E learning cycle increased student engagement and participation in activities, and it helped the students in the study successfully learn about the lesson topic (pp. 178-179). It is important to note that there are many factors a teacher

cannot control that affect student engagement, but there are ways to promote engagement and support students during their learning process.

Students can be engaged in content by giving their full attention, playing an active role in activities, having an emotional connection to the content, and many other ways. Engagement looks different for each student, which stresses the importance of not assuming that a student is not paying attention or doing their work. Payne (2019) explained the different factors that engagement is composed of and how they affect students. It is important to note that each student learns differently, which means that each factor will not have the same effect on each person. For example, some students might be extremely excited to work in a group, but other students might prefer to work by themselves. Payne (2019) describes engagement as a combination of the four components of: intrinsic motivation, extrinsic motivation, functional connectedness, and emotional connectedness. For students to be fully engaged, they need to be motivated about the lesson, what they will gain from completing the lesson, be present, and have a desire to achieve. With these factors depending on the interest and involvement of the student, flexibility is needed to address the different needs of the students in the classroom (Payne, 2019, pp. 647-652). The 5E learning cycle addresses this concern by allowing students to have at least some say in what they learn and how they learn it.

A key piece of student engagement is interest and connection to the content. This can be challenging, specifically for STEM, because students likely do not feel connected to the scientists they are learning about. An article by Jordan, Fern, Morris, Cross, and Mathur (2014) explains that engagement involves behavioral, cognitive, and emotional engagement. Most students need multiple types of engagement to be academically

successful. Other factors such as motivation, support from others, and relationships also influence engagement and academic success. If students are being encouraged and supported and have strong relationships with educators and other students, they are more likely to thrive in school. Jordan et al. (2014) conducted a study to determine what factors influence the frequency of the three different kinds of engagement. Because the majority of scientists are white males, they decided to have all male participants from a rural school in the United States. This study observed that movement was strongly correlated with engagement, and fidgeting was one of the main factors that led to disengagement. It was also noted the participants were the most successful when they were exposed to multiple kinds of engagement, which is something the 5E learning cycle can provide (Jordan et al., 2014, 673-677).

In addition to the 5E learning cycle, Adams and Miele (2016) states that free-choice learning also increases engagement and interest in STEM. Implementing free-choice learning requires that students have at least some control over what and how they are learning. To ensure that the objectives and curriculum requirements are being met, teachers can implement guided-choice learning. This still gives students the opportunity to control their learning, but it is in a specific subject area or within a project. Adams and Miele (2016) also explained that accountable talk should occur during the evaluation stage, which requires students to explain and justify what they observed or concluded. Accountable talk opens up the conversation of the subject matter, and it gives other students a final opportunity to share their thoughts and learn from others (Adams & Miele, 2016, pp. 52-54). Increasing free-choice learning in the classroom can lead to



increased engagement, but other factors still contribute to the level of engagement of each student.

Lewis, Huebner, Malone, and Valois (2011) conducted a study to identify if there is a connection between student engagement and life satisfaction. Previous studies have determined a connection between behavior problems and life satisfaction, with lower life satisfaction leading to more behavior problems. This study aimed to discover how mental health, social, and family variables, which influence life satisfaction, are connected to what goes on in the classroom. Their sample was composed of 779 students from a middle school in the southwest area of the United States. They collected data on the behavioral, emotional, and cognitive engagement and life satisfaction at two different points in the school year. From this data, they were able to determine a significant relationship between behavioral and emotional engagement and life satisfaction. Lewis et al. (2011) was able to determine that factors such as emotions, life events, and satisfaction with life overall, influence a student's experience and performance in the classroom (pp. 250-252). Providing students with content on health, emotions, and self-care can assist students with the hormones and emotions that come with growing up.

A study conducted by Yang, Bear, and May (2018) found that social emotional learning (SEL) has a strong connection to student engagement. SEL gives students the tools to properly engage with others and the content they are learning. When teaching SEL, systematic instruction should be given that focuses on real life application and the ongoing learning of students. This means that students need the opportunity to apply and practice what they are learning. There also needs to be a safe learning environment with a positive atmosphere, so that students are able to practice their social emotional skills.

Research has shown that SEL occurring in school increases attendance, interest in learning, and achievement. The use of SEL can also be used to help students that are struggling with behavior because they are learning how to set goals, work with others, and realize how the content is relevant to them (Yang, Bear, & May, 2018, pp. 45-47).

An article by Hirsch, Ennis, and Driver (2018) discussed three strategies for supporting students with learning difficulties. This article focused on difficulty with mathematics and behavior, but the provided strategies can also be applied to other areas of STEM. First, teachers should give students many opportunities to respond in different formats. An opportunity to respond can be as simple as a thumbs up or answering a question. Giving students the chance to respond has been found to increase participation, staying on task, and achievement. Second, Hirsch et al. (2018) discussed using a token economy in the classroom, which is a form of positive reinforcement (p. 8). When students do something positive or has been working to improve their behavior, they are rewarded with a ticket or token. When students have enough tickets/tokens, they can use them to buy a treat or a reward. This strategy promotes on task behavior and student engagement. Lastly, implementing self-monitoring can help students stay on track and evaluate their behavior. Self-monitoring is when students record if they portrayed a desired behavior or action or if they did not (Hirsch et al., 2018, pp. 8-9). This requires students to evaluate themselves and their behaviors, which can help them set goals for improvement.

Student engagement is a critical piece of learning and success. Student interest, relationships, events out of school, and life satisfaction are all factors that can influence engagement in the classroom (Lewis et al., 2011, pp. 250-252). Engagement looks

different for each student, and there are multiple different kinds of engagement. Students can be behaviorally, cognitively, and emotionally engaged, and most students need to be engagement in multiple ways to successfully learn (Jordan et al., 2014, 673-677).

Implementing social emotional learning and different styles of classroom management can encourage student engagement, as well as focusing on student-student relationships and teacher-student relationships. Putra et al. (2018) also found that implementing the 5E learning cycle increased student engagement and participation in their study.

Implementing this constructivist way of learning as well as free-choice learning can improve student engagement in STEM.

**Equity.** As our education system is evolving and improving, there has been a change of focus from equality to equity. This change places a higher focus on giving students the resources that they need to thrive, not giving each student the same resources. From an equity standpoint, each student comes to school with different life experience, learning styles, and amount of knowledge. To address these differences, students are given the instruction and resources that meets them where they are at. For example, English language learners are the fastest growing population in the United States (Januszyk et al., 2016, p. 47). These students will not be able to thrive if they are treated the same as other students because they need a different kind of support and possibly extra language instruction. Equitable education focuses on distributing resources to the students that need them, not giving each student the same educational experience. The New Generation Science Standards (NGSS) are also aiming to address equity and diversity issues in education, as they work to create relevant standards for the diverse population of students in the United States (Januszyk et al., 2016, pp. 47-48).

Equity education also addresses that the structures of our society are still very oppressive, which deprives some students of the opportunities that they deserve. Students in urban districts do not receive the same support and educational opportunities that rural and wealthier schools do, which continues the cycle of inequality and oppression. Currently, the representation of scientists in our country is disproportionate because of the lack of people of color and women in the STEM field. An article by Avendano, Renteria, Kwon, and Hamdan (2019) explains that this inequality starts in elementary and middle school when marginalized groups are deprived of the education and opportunities that others are given. Because of the inaccessibility of education and exposure to STEM, marginalized populations will continue to not be represented in the field of science (Avendano et al., 2019, pp. 67-68) To address the injustice that is occurring across the nation, funding and resources need to be distributed equitably.

To ensure that schools are being equitable, more education/information can be provided to educators and administrators about Title IX. This educational amendment states that no one can be excluded or discriminated against based on sex. Most people connect Title IX to participation in sports, but it also covers all other educational opportunities as well. Despite this policy, women and individuals of color have not had the same opportunities in the field of career and technical education. According to Toglia (2013), since Title IX was established, there has been little improvement in the gender divide in career and technical education. Other factors besides accessibility also prevent women from pursuing STEM, such as societal pressures and stereotypes about what roles women should portray in society. For women and other oppressed groups to see themselves as scientists, there needs to be more exposure to content and frequent

encouragement for students to pursue whatever career they are passionate about (Toglia, 2013, pp. 14-15).

To engage and interest students in STEM content, students need to be able to connect their knowledge and experience to what they are learning about. A study conducted by Brown (2017) aimed to identify the connection between inquiry based learning and culturally responsive practices. This study reviewed 52 articles on these two topics to identify the key pieces of each type of teaching practice. There were many factors identified that complemented each other, such as gathering, evaluating, communicating, and explaining information. The use of culturally responsive practices in inquiry based learning allows students to make connections between the content and their own life experiences. Students can identify how human impact has affected their community, and how current legislation is neglecting to protect all land, but especially Indigenous land. Creating and using models also gives students to explore their understanding of knowledge, and how they see the different pieces being represented in their world (Brown, 2017, p. 1143). To ensure that students are getting an equitable educational experience and exposure to STEM, it is important to allow students to make connections between content and their culture and life experiences. Teachers should also consistently encourage students to personalize what they are learning, which will help them make connections and engage in critical thinking (Brown, 2017, pp. 1166-1167).

A recent movement in STEM education has led to the implementation of makerspaces in many schools, community centers, and local libraries. Makerspace gives students a variety of materials and activities, and the students are able to make whatever they wish. Students can experiment with materials, learn more about the content behind

their chosen activity, and the whole learning process is based on the interests of the students. Implementing makerspaces gives any student the opportunity to view themselves as a scientist, despite the reality that most scientists are white males. To make sure that makerspaces are equitable, it is important to celebrate and encourage the different experience and knowledge that each student has. These experiences will shape how students interact with the materials, which shows how important it is to support students during the creative process. Students should also be encouraged to make connections to the projects that they choose to do, which will increase their interest and involvement in the making process (Ryoo and Calabrese Barton, 2018, pp. 3-6).

In addition to the lack of STEM exposure for marginalized communities, many teachers do not have the proper training or education to implement equitable STEM education. For teachers to properly help students in their learning process, they need to acknowledge the cultural identity of each student and how it shapes their understanding. Without culturally relevant pedagogy in STEM lessons, students will struggle to retain and understand the content because they are unsure of how it is related to them. Another issue in our school system is that there is a lack of resources, especially for low-income schools. This is another situation that prevents students from exposure to STEM, which continues the unequal representation of individuals in STEM careers. Giuriceo and McLaughlin (2019) discuss five elements that need to be present for STEM education to be equitable. First, there need to be accessible opportunities for everyone. Students also need to learn in an empowering and social environment where they receive continuous support throughout their educational journey. There also needs to be flexibility with projects and experiments to address the needs of each student. Lastly, gender and culturally relevant

pedagogy should be implemented in each STEM lesson (Giuriceo & McLaughlin, 2019, pp. 20-21). For STEM education to be equitable, teachers need to be aware of how they are providing instruction for their students, and the impact that their approach to education can have on their students.

A study completed by Lee, Hart, Cuevas, and Enders (2004) identified the beliefs and views of teachers within a large urban district. Fifty three teachers from six different elementary schools were included in the study, which aimed to identify how teachers felt about inquiry based learning in science, and if professional development had a strong impact on these perspectives. Throughout the school year, these teachers attended different professional development sessions and trainings that educated teachers about the benefits of inquiry based learning and how to implement it into the classroom. At the end of the year, the teachers within the study had more specific goals for science instruction, and they had a better idea of how to support the development of critical thinking and problem solving skills. The science content that the teacher knew had also improved, which allowed them to better teach and implement the lessons and activities (Lee et al., 2004, pp. 1030-1037). This study demonstrates the need for professional development and training around the area of STEM. For our education system to be equitable, teachers need further knowledge on how to implement inquiry based learning to develop critical thinking and student centered learning in our schools.

America's current education system needs to continuously evolve and reform as the field of STEM and the population of our country changes. Educational amendments and reforms that occurred many years ago are still not being properly implemented in our schools, such as the Title IX amendment. Marginalized groups continue to be oppressed

and mistreated by structures of privilege, which causes an unequal representation of individuals in STEM careers (Toglia, 2013, pp. 14-15). For STEM education to be equitable, resources need to be provided to schools that need them, and culturally relevant pedagogy needs to be implemented along with inquiry based lessons. To support teachers during their implementation of STEM lessons and inquiry learning, more professional development needs to occur (Giuriceo & McLaughlin, 2019, pp. 20-21). This will allow educators to understand the importance of inquiry based learning, and the need for emphasizing that anyone can be a scientist, despite the stereotypes this country upholds.

### **Summary**

This chapter discussed the 5E learning cycle and how it promotes critical thinking, problem solving skills, and student centered learning. During this inquiry process, the teacher is the guide through the learning process, while the student is the scientist and experimenter. Students also collaborate with others to discuss their understanding of the content, and dive deeper into how the information they are learning is relevant to them (Dass, 2015, pp. 8-9). The 5E learning cycle allows students to have more choices in the learning process, which leads to increased student engagement. Students can be engaged in multiple different ways, and engagement can look different for each student. Different types of engagement include behavioral, cognitive, and emotional. For most students to be successful in the learning process, they need to be engaged in more than one way (Jordan et al., 2014). To encourage students to engage in STEM and connect the content to their life, STEM education needs to be equitable. Marginalized groups are still not given the opportunities that they need and deserve,



which means they do not have the resources and experiences that privileged institutions have. This injustice has led to an unequal representation in the STEM field, which will continue to occur unless our education system is reformed (Toglia, 2013, pp. 14-15).

By implementing the 5E learning cycle, this project aims to increase equity, engagement, and student centered learning in STEM content. The following chapter will describe the details of this project to address the research question: How will integrating the 5E Learning Cycle into STEM Freedom School increase student centered learning? The upcoming chapter will provide a specific plan for implementing the 5E learning cycle for a specific student population of STEM Freedom School. The fourth and final chapter will provide a conclusion and reflection of the project.

## **CHAPTER THREE**

### **Method**

#### **Introduction**

This project was completed through a collaboration between a local museum and a STEM Freedom School. These organizations have been connected for almost 5 years, with the goal of empowering youth to change our world through science. The collaboration between these organizations gave students in the community the opportunity to improve their reading literacy skills, and to also improve their scientific literacy. This curriculum project was completed to improve the STEM curriculum to incorporate more student centered learning and inquiry in each lesson. This project answered the research question: How will integrating the 5E Learning Cycle into STEM Freedom School increase student centered learning?

To make this project successful, research was collected on the 5E Learning Cycle and its implementation, equity in education, and engagement. The 5E Learning Cycle was implemented into the science curriculum for STEM Freedom School, in hopes that student engagement, student centered learning, and inquiry would increase. When providing any form of education, it is critical to be equitable, so that each individual is receiving the support that they need. In STEM especially, research has shown that the majority of scientists are white males, which does not accurately represent the population of this country. One of the main missions of STEM Freedom School is to show that anyone can be a scientist, and hopefully, to have our scholars be inspired to further explore science as a possible career path. Engagement is also a factor in the process of curriculum writing because students will not be able to partake in student centered

learning or inquiry if they are not engaged in the content. When creating the curriculum for this summer program, the lesson topics and experiments were adjusted and selected to gain the interest and engagement of our scholars.

### ***Context/Setting***

The Freedom School connected to this project is located at a charter school that hosts this summer program, so many of the students that attend the program attend the charter school during the school year. The students that attend this school are mainly Hispanic/Latino, Black/African American, or Asian. Students that attend STEM Freedom School as well as the teacher implementing the curriculum are the intended audience for this project. This audience was selected based on the professional and personal connection of the researcher. During the summer, there are around 160 students and 12 STEM teachers involved in the program. Many of the students come back to this program every summer and have siblings that are also involved in the program. The Freedom School program focuses on community building and values the role of family in the education process. The program is free for students to attend, they receive two free meals each day, and they go on a free field trip each week. The only requirement is a family member needs to attend a weekly dinner and “parent empowerment” night. Everyone is given a free catered meal, program details are discussed, and community members are invited to join. This is a chance to involve parents with community events and resources, show the work that their students are doing, and connect everyone together as a “Freedom School family”.

To further involve community members in this program, there is a different read aloud guest every day that either works or lives in the community. Inviting different read

aloud guests shows all of the different careers that students could pursue, and that each individual uses their literacy skills each day. To address the community focus of the school and to implement culturally responsive pedagogy, each lesson was related to the student population with a focus of improving our community and world. In the future, Freedom School teachers will work to implement and discuss STEM justice, which is a movement to use STEM to address systems of oppression. This will take place during the reflection and evaluation piece of the lesson, and it allows the teacher and students to discuss how we can better our community.

**Rationale.** This project needed to be completed because the previous curriculum was outdated, repetitive, and it was not at the appropriate level for the intended audience. The students at the program had been doing the same projects for years, which led to disengagement and behavior issues. The content covered in each lesson was also not interesting to the students, and the lessons did not explain how the content is relevant to the students. Without interest and connection to the material, the students could not be fully engaged in each lesson (Payne, 2019, pp. 647-652). The curriculum for the STEM Freedom School was also teacher led, which prevented the students from exploring and experimenting with the materials. Students were not able to guide the path of the lesson, pursue their interests, and be scientists with the set curriculum led by the teacher. The previous curriculum was also not at the appropriate level for the students, which caused instructional and behavioral issues. The lessons for level one (K-2) were too complex, which caused frustration and complications when attempting to have younger students' complete complex projects. The lessons at level two (3-5) needed to be more challenging

and have more content included in them. The lessons at level three (6-8) include more challenging content, but lack student engagement and culturally relevant pedagogy.

**Framework.** The framework used for this curriculum project was the 5E learning cycle, and each lesson plan was completed in a lesson plan format to reflect the five different steps in the cycle. This framework focuses on student centered learning, critical thinking, and inquiry. This framework starts with the first stage of engage. During this stage, the teacher introduces the content and assess what prior knowledge the students have. Second, the explore stage occurs, where students ask questions and try different methods to solve the problem. Third, students explain their understanding of the content and discuss their perspective with other students. Fourth, students use their new understanding of the content to elaborate and dive further into the experiment. Lastly, students finish their project and evaluate their end result and the inquiry process (Allen et al., 2019, pp. 50-51). This cycle can be modified to address the needs of the students in the classroom, and the process does not need to be completed in one day. This cycle gives students the opportunity to explore their interests, problem solve, work with others, and to be scientists and experimenters.

**Project Completion.** During the Summer of 2020, the current lesson plans were adjusted, the 5E Learning Cycle was implemented in each lesson plan, and new lessons were created to promote engagement and include student interest. This project was completed from June to August 2020 by creating two new lessons every two weeks. The Manager of Internships checked in on progress, the new/adjusted lessons, and made sure that at least two lessons were completed every two weeks. This curriculum will be used for STEM Freedom School during the summer of 2021 to increase student engagement

and student centered learning. The new curriculum has been reviewed by the Manager of Internships, and it will be discussed and reviewed by the new group of interns for Summer 2021.

After the new teachers explore the lessons and the 5E learning cycle, a presentation will be given to explain the inquiry cycle and what is required in each stage. This will allow for the new teachers to assist students during their experiments and encourage critical thinking. The presentation will also include information on modifications and strategies that can be used to assist struggling students. A slideshow will be created for the presentation, and the Manager of Internships will be giving the training to their new staff. This presentation will be the most efficient way to educate new teachers each summer, which will help them teach this style of lesson over the summer.

### **Summary**

This chapter described the context of the Freedom School program, and the students and teachers that will be impacted by this curriculum. The students of this Freedom School have completed the same lessons multiple times, teachers have struggled through complex lessons with younger kids, and students have been disengaged in the learning process. Behavior issues have escalated, and teachers have been struggling with motivation and interest. The new curriculum utilizes the 5E inquiry cycle, which allows students to have freedom in the learning process and have a say in how they complete the experiment. This cycle helps students address their interests, improve their problem solving skills, and engage in critical thinking. Deeper content and information have been added in each lesson, and the new curriculum is appropriate for the intended grade levels. The new curriculum will be implemented in the Summer of 2021, which will impact

around 160 students and their perspective of STEM. In the final and fourth chapter, the conclusion of this project will be provided, as well as a reflection on the completion process.

## **CHAPTER FOUR**

### **Conclusion**

#### **Introduction**

This chapter will discuss the completion of the project “The Implementation of the 5E Learning Cycle in STEM Freedom School”. This project aimed to answer the research question: How will integrating the 5E Learning Cycle into STEM Freedom School increase student centered learning? I implemented the 5E inquiry cycle into STEM lessons to provide further opportunities for critical thinking, inquiry, and engagement. The previous curriculum was outdated, repetitive, and it was not at the appropriate level for the students. I worked to create lessons that facilitated critical thinking and engagement, while promoting equity within the classroom.

In this chapter, I will discuss how I have grown as a researcher, learner, and writer through the completion of this project. The research that was the most prominent and beneficial to completing this project will be reviewed and discussed. The limitations, implications, and benefits of this project will also be provided. Furthermore, I will explain the next steps for this curriculum project and possible recommendations for future research. Lastly, I will provide a conclusion of the project. Each of these aspects will be discussed to define the importance of this project, and the impact that it will have.

#### ***Major Learnings***

Before this project, I had never completed a major research project in the field of education. In undergrad, I completed various communications projects, including creating my own study, collecting data, and evaluating the results. The idea of completing a very different kind of project was intimidating, especially because I had no idea where to start.



I knew that I wanted to create a project that benefited a program that I was passionate about and that had helped me get my start in teaching. Through initial background researching, I realized that I could use a new framework to improve and create new lessons for the Freedom School I spent three summers with. With a new sense of passion and excitement about my project, I jumped into the researching process.

To complete this project, I read, annotated, re-read, and summarized over twenty articles. I spent hours reviewing research and learning more about the cycle I would be implementing, as well as the positive effects that could occur. During the research process, I became a more organized and efficient person. I have always struggled reading articles on a computer, so I made the decision to print out each of the articles I would be including in my literature review. This meant that I had hundreds of pieces of paper to organize and keep track of. I did not like the idea of wasting paper, but I knew that I would not be able to take effective notes and truly learn the new content unless the paper was right in front of me. As I read, I highlighted important information, added comments and questions on the articles, and I wrote the in-text citation for each article on its front page. This made me a stronger researcher because I was fully engaged in the content I was studying, which made it easier to summarize and explain the new content in my literature review.

This project also pushed me to write in a different format than I was used to. While completing my communications degree, I wrote countless academic papers filled with important information about the given topic. I have been told by professors that I am a strong academic writer, but I have little experience writing in the form of a narrative. After so many years of thinking and writing academically, I found it very challenging to

write from my perspective and even include “I” in what I was writing. It went against everything that had been ingrained in my mind. Yet, I pushed myself to partake in this new kind of writing, and that has made me a stronger writer overall.

As a learner and student, I was forced to change how I previously went about school work. I used to write a paper within a day or two, then move onto the next assignment. I completed projects throughout undergrad, but they rarely lasted more than half a semester. This project has many different components and requirements, and it is not something that can be completed within a few weeks or even months. I learned how to complete a small chunk of work every few days, instead of trying to complete everything all at once. Another learning experience that was very unexpected was getting a concussion during the last month of the semester. I had plans to finish all of my work, and they were completely halted when I got a concussion. I was not able to look at screens, complete stimulating activities, or even be in places that were too bright. This injury stopped the progress I was making, and I had to learn how to be patient with myself. I have always held myself to a high standard, so taking two weeks off was not something I was used to. I also had to slowly dive back into my work by completing a short amount of work each day, then giving myself time to rest and reset. This experience was definitely a challenge, but I overcame it and became a stronger learner and student because of it.

This research experience allowed me to grow as a researcher, writer, and learner. My previous research projects were very different, so this was a new and exciting experience for me. I found a project that I was passionate about and looked at countless pages of research to better understand my topic and project. I became more organized and

efficient, which allowed me to dive deeper into my project. I also grew as a writer by practicing writing in the form of a narrative, which is not something I had a lot of experience with. Lastly, I changed as a learner and student when I allowed myself to complete a small piece of work each day and realizing that I had to be patient with the process. Overall, this project has helped me become a better educator, researcher, writer, and learner.

**Literature Review.** The research that was critical to my project explained each of the five steps in the 5E learning cycle. Allen, Harron, Qadri, and Rodriguez (2019) and Dass (2015) broke down each component of the cycle and discussed the elements of each stage. Their definitions and examples allowed me to smoothly implement the 5E design into my lesson plans. The steps of Engage, Explore, Explain, Elaborate, and Evaluate each have a different desired outcome, and I had to understand each stage to comprehend the impact the 5E learning cycle can have. Without studying the research of Allen et al. (2019) and Dass (2015), I would not have been able to fully understand the purpose of each stage, and how to properly include them in lessons to promote student centered learning.

Another source that influenced my work was Jordan, Fern, Morris, Cross, and Mathur (2014). This source explained the components of engagement, which involve behavioral, cognitive, and emotional engagement. Jordan et al. (2014) also explained that many factors contribute to student engagement such as motivation, support, and relationships. For students to become engaged, their needs have to be met in a safe and supportive environment. One of the main goals of my project was to increase student engagement, which was influenced by the research of Jordan et al. (2014).

The final portion of my literature review looked into equity education. To ensure that this project would increase equitable educational opportunities, a literature review about equity was conducted. Avendano, Renteria, Kwon, and Hamdan (2019) addressed that our society is still very oppressive, which influences students and the educational experience they will have. Urban school districts do not obtain the same financial support and opportunities that other wealthier or rural schools receive. This inequality starts as early as elementary school, which has caused the representation of scientists in our country to be disproportionate. With education promoting equity, marginalized groups will have a greater chance at partaking in STEM fields (Avendano et al., 2019, pp. 67-68). This research was very important to my project, as the goals of this project included increasing engagement and equity within the students' learning experiences.

While completing this project, I found a new understanding of the Sheltered Instruction Observation Protocol (SIOP). Nargund-Joshi and Bautista (2016) proposed combining the 5E cycle with the SIOP to increase support for English language learners in the classroom. The SIOP protocol provides academic language, content vocabulary, and more background information to help students comprehend the lesson (Nargund-Joshi and Bautista, 2016, pp. 27-30). As I was completing my project, I found that certain topic areas benefited from the integration of the SIOP. Because I was creating a curriculum for students that I had previously worked with, I was aware of what content was completely new or could be challenging for my students to grasp. When I was aware that most students did not have any prior knowledge in a specific subject area, I integrated the SIOP into the 5E cycle to provide further support and instruction to the

students. This new learning helped shape my project and ensure that I was providing equitable and engaging learning opportunities.

To complete this project, I reviewed many different sources about various topics involving STEM education, inquiry, engagement, and equity. Allen et al. (2019) and Dass (2015) provided me with in-depth descriptions of the 5E cycle, and the objectives that each stage holds. Jordan et al. (2014) helped shape my understanding of engagement, which involves many factors in and outside of the classroom. Avendano et al. (2019) provided insight on equitable education, and the oppression that still occurs in our society. Furthermore, Nargund-Joshi and Bautista (2016) proposed the combination of the SIOP and the 5E learning cycle. Including components of another instructional theory was extremely influential to my project because it allowed me to include more academic language and content to support and encourage critical thinking.

***Limitations.*** This project aimed to create a curriculum that was relevant, engaging, equitable, and student centered while using the structure of the 5E learning cycle. There are a few limitations worthy of noting. I was able to create two weeks of lessons about Environmental Studies and Sustainability for students in Level 2, but I was not able to create a new curriculum for the whole program (eight weeks). I was also not able to create a new curriculum for all three levels of Freedom School (Levels 1, 2, and 3). Another possible limitation is the materials available to students. Each lesson includes a hands-on experiment that the students get to complete. The Freedom School that I worked with had access to all of the materials required to complete the lessons, but it is possible that other programs might not have access to the required materials. Without the required materials, some of the activities would have to be substituted for others.

***Implications.*** The possible implications of this project include the effects that occur when equitable and engaging education is provided. Because of the oppressive nature of society, studying or working in STEM fields has not been an easily accessible option for underrepresented communities. By incorporating the 5E learning cycle into STEM lessons at the beginning of a student's educational journey, it provides students with access to STEM, which could inspire them to pursue a career in the field. If more individuals of underrepresented populations pursue STEM careers, the field will become more inclusive and accessible to everyone. With the implementation of this project, I hope that all students at Freedom School see that they are all scientists, and that have the ability to make an impact in this world. Furthermore, this project benefits the profession because it provides Freedom School students with a curriculum that was created specifically for them to meet their needs, engage them, and inspire them to make a difference. Student centered learning is critical in educational settings because it motivates, intrigues, and engages student in important and relevant content.

***Future Research and Next Steps.*** My suggestions for future research projects are to keep altering the 5E learning cycle to benefit the needs of a specific student population. This cycle has already been modified over time, and it should keep changing and improving to give students the best educational experience they can have. The 5E inquiry cycle can be combined with other frameworks to teach certain topics/subjects in a new and exciting way. I hope that researchers continue to be creative and innovative by combining instructional techniques to benefit students. Similar projects that could be completed are creating a curriculum for the other levels of Freedom School or finishing the Level 2 curriculum that was started in this project.

Now that this project is completed, I will provide the curriculum to the current manager of the STEM Freedom School. I plan to go over each specific lesson with the manager, as well as explaining the benefits of using the 5E learning cycle. I will also create a presentation for the manager to use when introducing the 5E learning cycle to future STEM educators. This will help future teachers understand the stages of the cycle, and how to properly implement them into a lesson. With the approval of the manager, the new lessons will be implemented in the Summer of 2021. After the implementation of the new curriculum, I will meet with the manager of the program to create a plan of action for the remaining pieces of the curriculum. After the Summer of 2021, the whole curriculum could possibly be modified to include the 5E learning cycle.

### **Summary**

This chapter provided insight on how I improved as a researcher, writer, and learner throughout this capstone project. The literature that was critical to this project was discussed, as well as the influence it had on the competition of the project. The limitations, implications, and benefit to the profession were also provided in this chapter. Lastly, future suggestions for research and the next steps for this project were discussed. This project was completed with the objective of answering the research question: How will integrating the 5E Learning Cycle into STEM Freedom School increase student centered learning?

Most importantly, this project was completed to benefit the current and future students of the STEM Freedom School. I had the privilege of watching students of this program grow and learn over three summers, and they will always have a special place in my heart. Working for Freedom School gave me my start in education, and I am

extremely grateful for the amazing and unique way it started my career. With the completion of this project, I created a curriculum that is relevant, engaging, and that promotes equity to benefit the students of the STEM Freedom School. I hope that this curriculum inspires students to dive deeper into STEM, and to continue to be a lifelong learner as the world changes around them.



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